

COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF AGRICULTURE.

BULLETIN No. 31.

The Economic Status of the Mole.

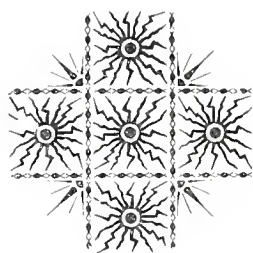
BY

HARRY WILSON, GUM TREE, PENN'A.



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1898.



LETTER OF TRANSMITTAL.

GUM TREE, CHESTER CO., PA., JANUARY 1, 1898.

HON. THOS. J. EDGE, SECRETARY OF AGRICULTURE :

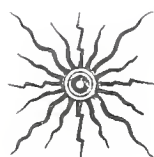
My Dear Sir: I have the honor to submit the following report, in accordance with a commission in which I was instructed to prepare and place on file, in the office of the Department, a report on "The Economic Status of the Mole."

The first part of the report consists of a study of the life, habits, etc., of the species of the mole family (*Talpidea*), known to be indigenous to the State of Pennsylvania: the second, bearing upon the economic relation of this family of mammaliae to agriculture, together with a tabulated statement intended to show the distribution of the mole throughout the State, as derived from information contributed by correspondents in various parts of the Commonwealth.

I am, with respect,

Yours truly,

H. WILSON.



THE MOLE FAMILY

(*Talpidae*)

IN

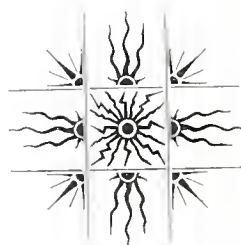
PENNSYLVANIA

WITH

The Economic Relation of the Mole to Agriculture,

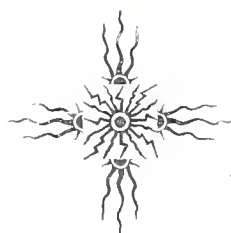
BY

HARRY WILSON.



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INTRODUCTION TO SUBJECT.

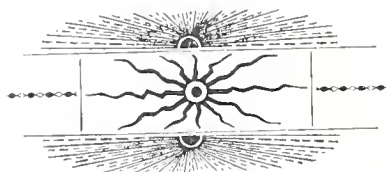
The mole family (*Talpidae*), of North America has been divided into four Genera, namely: *Scalops*, *Scapanus*, *Condylura*, and *Urotrichus*. The genus *Scalops*, being designated by Cuvier (in 1800), presents three species: *Scapanus* being determined by Pomel (in 1842), presents two (or possibly three) species; *Condylura*, by Illiger, (in 1811), has probably but one specie, and *Urotrichus*, by Temminck (in 1838), has likewise but one specie.

The several genera, though differing quite distinctly one from another, yet agree in their general appearances; having a stout, clumsily formed body, without that constriction denoting the neck part, usually seen in other animals; short legs, with hand-like fore-feet; no external ears; eyes very small, much concealed by hair, and in some specie there being no opening in the skin over the orbit.

The mole family has been found to be distributed throughout every portion of the explored world, except in certain portions of the inter-tropical regions. The species are, however, closely restricted, each region having its characteristic one. Thus, of the seven (or possibly eight) species which are indigenous to the United States of America, but one has been identified as existing in any other portion of the world, viz, the *Urotrichus*.

Upon the best authority obtainable from printed works relating to the subject, and from reports received from naturalists throughout the State of Pennsylvania, but two species of the mole family indigenous to the United States can positively be considered native to the State, namely, the "Common Mole," *Scalops aquaticus*, (Genus, *Scalops*), and the "Star-Nosed" mole, *Condylura cristata* (Genus, *Condylura*).

However, there is so great a probability that another specie, the "Hairy-Tailed" mole, *Scalops breweri*, (Genus, *Scapanus*), is likewise native (although not a single specimen has been reported to me, as having been collected within the limits of the State), it being found in the adjacent states of New Jersey, New York and Ohio, that I have concluded to include it in this report, using the descriptions as given by other investigators.



PART I.

THE MOLE FAMILY IN PENNSYLVANIA.

Sub-order—*Insectivoria*.

Family—*Talpidae*. (Moles).

Genus—*Scalops*, (Cuvier, 1800.)*

Specie—*Scalops Aquaticus*, (Linnaeus, 1758.)||
“Common Mole.”

† Specie Ch. Teeth, 36; eyes and ears excessively minute, the former not covered by integument; nostrils, antro-superior; palms, broader than long, claws included; tail, nearly naked; feet fully webbed; color, dark plumbeous with occasionally a brownish tinge, feet and tail white.

Measurements. From an average (of thirty) specimen. From end of nose to incisor teeth, .40 inch; to eye, .75 inch; to ear, 1.125 inches; to back of head, 1.50 inches; to root of tail, 5.125 inches; to end of tail, or total, 6 inches. Nose, .40 inch; tail, .875 inch; Forefoot, .875 inch long, including nail, and .875 inch wide. Hind foot, .875 inch long, including nail, and .31 inch wide.

‡ Habitat. “Atlantic coast region, from Mass. to Florida, and west to the Mississippi R.”

This mole, which has been described as early as the year 1758 by Linnaeus, under the name *Sorex Aquaticus* (receiving its sub-specie title, *Aquaticus*, from the affirmative evidence, indicative of its aquatic nature, furnished by its webbed hind feet), presents in general those characteristics of form common to the mole family.

The body is quite stout and thick and is covered with a fine, close and velvety fur of a dark plumbeous color, which in mature adults has a golden brown or bronze colored sheen on top of head, shoulders and breast; the fur on the back is the longest, about .31 of an inch; each hair upon examination may be seen to have five shade bands of alternating light (beginning at skin), and dark. In young or immature individuals the fur presents various shades of light drab “silvery” to dark plumbeous; in every case the fur on lower part of body being a shade lighter than that on back, and having a medial line on belly, running from breast to base of tail, of a brown shade.

* Cuvier, G. “*Leçons d'anatomie comparée*,” &c I, 1800, Paris.

|| Linnaeus, C. “*Systema naturae*,” &c, 10 ed., I, 1758, p. 53.

† Baird, S. F. “*Mammals*,” in general report on zoology of the several Pacific Railroad routes, 1857, p. 60, Washington.

‡ Ib. -p. xxxiii.

The head is narrow and, taken in conjunction with the nose, it presents a much elongated, depressed and tapering appearance.

The nose is quite long and tapering, with a slight bulb at the end (Fig. 2.) The upper portion of the nose is entirely naked, the sides



Fig. 1. — $\frac{8}{16}$ *Scalops Aquaticus*.

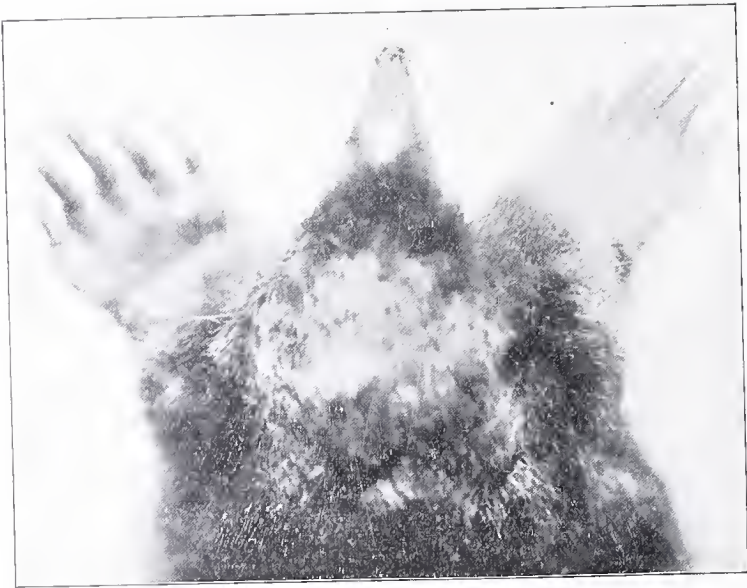


Fig. 2. $\frac{16}{16}$ *S. Aquaticus*—Top of head, showing upper part of nose, and location of ears, the dark circles at juncture of arms.

and under part (with the exception of the slight groove, which extends from the incisors towards the end), are slightly covered to almost the end with fine and short light-colored hairs. The under line of the muzzle is nearly straight, having but a slight upward turn at the end, where it has beneath the skin a small spatula-shaped cartilagenous bone, which, while it thus provides stability to this

portion of the nose, gives it the enlarged or bulb-like appearance. The upper part of the snout is quite sharply truncated for about .125 of an inch and then slopes gradually upwards toward the forehead. The nasal passages extend almost the entire length of the muzzle, having their crescent-shaped openings upon the top about .06 of an inch from the end in that portion which is truncated, so that the nostrils are antero-superior and cannot be seen from beneath or readily from the side of the snout. The whole muzzle is very flexible and is almost continually being turned from right to left and up and down while smelling for its food. Upon the slightest disturbance the muzzle is raised quite high (as if the more readily to scent the danger), thus exposing the front teeth or incisors. (See Fig. 3.)



Fig. 3. $\frac{18}{16}$ *S. Aquaticus*—Front view, showing incisor teeth.

There is no external ear (a fact characteristic of the mole), there being in this specie but the slightest projecting rim of skin surrounding the *meatus auditorius*, (or opening into the inner ear). The location of the ear may be readily seen, however, by a slight knob-like protuberance of the skin, of about .31 of an inch, the diameter of an ordinary lead pencil, upon the side of the head, just over the insertion of the forearm with the body. Upon this raised portion of the skin, the hair is only about one-half the length of the surrounding fur; in the centre is the external opening, of about .05 of an inch, into the inner ear. The knob-like protuberance in the skin (about the *meatus auditorius*) is explained by the fact that just within the skin or hide the auditory tube is suddenly enlarged into a chist arrangement of

about three times its former diameter. This tube is again restricted to its former size and passes into the skull just back and above the hinge of the jaw bone. The sense of hearing, like that of smelling, is very acute, making up in part for the restricted visual sense.

The eye, which is located about half-way between the end of the nose and the ear, is excessively small; it is so concealed by the thick fur that it is with some difficulty that one can locate it. Upon parting the fur the eye is seen as a bluish speck about .03 of an inch in diameter, through the skin, the opening in the integument being never larger than the hole made by the prick of a fine needle point. In four specimens out of thirty-six gathered during this investigation not the slightest opening could be discerned even with a magnifying lens. There is a slight space (about .06 of an inch), immediately over the ball of the eye, which the hair does not cover. In the centre of this space about the opening in the integument there are growing five or six hairs quite as long as any in the surrounding fur. It is doubtful that eye is of any visual use,* yet I believe it enables the mole to discriminate between light and darkness, for it quickly retreats and seeks cover when strong light is thrown or falls upon the fore part of the body.

The mouth is quite large, having a depth of about .375 of an inch, as deep as the length of the snout, so that the front face of the incisor teeth fall about midway between the end of the muzzle and the angle of the mouth. The lips close well over the teeth.

The fore feet are very large in proportion to the size of the animal and are slightly broader than they are long; the palms projecting on the inner side beyond the first claw, thus giving an appearance that would suggest the idea of the mole having at one time devel-

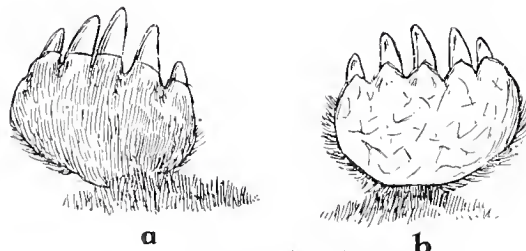


Fig. 4., $\frac{16}{12}$

Right fore-foot, or hand of *Scalops Aquaticus*.
a—top; b—palm.

*"The mole far back in the past had eyes, and gained its livelihood above ground in the broad light of day; but owing to some change in its surroundings it was forced to burrow beneath the surface of the earth; consequently its organs of sight have degenerated and are now practically worthless so far as vision is concerned. All moles, however, can tell darkness from light, consequently are not totally blind—a certain amount of sight yet remains. This is due to the fact that, although the optic or sight nerve, on examination, is invariably found to be atrophied or wasted, there yet remains in the shriveled nerve-cord true nerve cells. These nerve cells transmit light impressions to the brain, etc."—James Weir, Jr., M.D., in *Popular Science News*, June, 1896, p.123.

oped a sixth claw (Fig. 4). The palm is naked, with a white skin much creased; the top of the foot is slightly covered with fine textured, light-colored hairs, there being a fringe of quite stiff hairs (about .06 of an inch long) around the edge, (particularly the basal portion of palm) of the foot for use in pushing earth. The claws are quite large and stoutly formed, the points being quite obtuse, the third claw being the longest, the fifth being slightly the shortest. The hind feet (Fig. 5), are not quite as long as the fore feet and being less than one-half as wide, at its widest, as it is long, it looks quite small; the foot is webbed to the base of the claws, the edge of the membrane, however, does not stretch between the base of the claws in a straight line, except during the greatest expansion of the foot as in swimming. The under part of the foot is naked, having a white smooth skin; the upper part is but sparsely covered by fine and short white hairs. There is, as in the case with the forefoot, a slight fringe of short bristle-like hairs about the heel and inner edge of the sole. The claws are quite slender and sharp pointed, the fourth being the longest, the first and fifth of about equal length, are the shortest.

The tail (Fig 5) is round, short (about .875 of an inch in length),

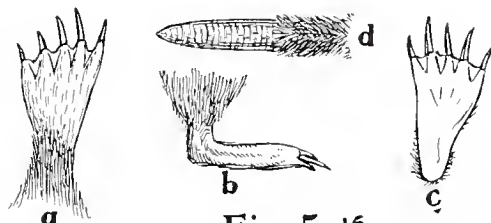


Fig. 5, $\frac{16}{18}$

Right hind-foot of *S. Aquaticus*, foot spread to show web; a—top; b—side, c—sole; d—tail.

and slender (the maximum diameter at about one-third length from base is .125 of an inch), and is slightly constricted at the base. It, however, enlarges rapidly to the basal third and then tapers gradually towards the end to an obtuse point. The basal third of the tail is well covered with short hairs of a color slightly lighter than the fur on the body, the remaining two-thirds or terminal portion is, however, so scantily coated with fine white hairs that this portion appears quite naked. The musk gland of the mole lies in the pelvic region and consists of two separate glands, each, in this specie, about as large as a man's thumb nail and about .125 of an inch thick. The matter therein is of a golden brown color, is quite offensive to the sense of smell, so that I know of no animal which will eat the flesh of this mole. The ducts leading from the musk glands have each

three orifices which open externally on each side and in front of the vent.

From an examination of the mammillary glands of the female specimens collected during this investigation, it would appear that they bring forth from four to six young, and that the season of parturition is from about the middle of April until about the middle of July.

Of the general anatomy of this mole (Figs. 6 and 7), little need be said. The skeleton in total is 5.50 inches (of the specimen No. 6

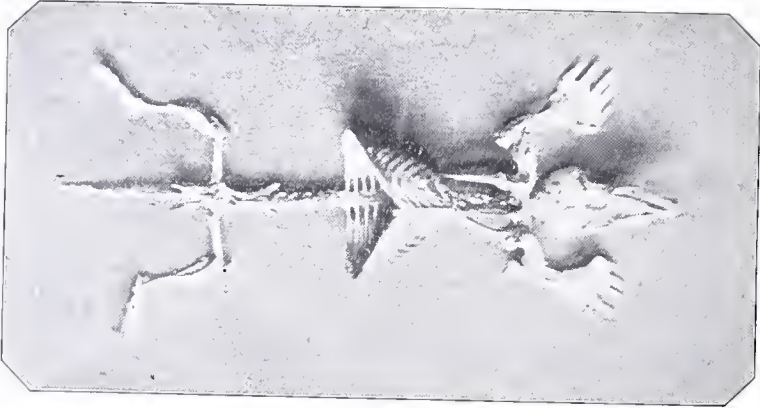


Fig. 6.— $\frac{8}{16}$ Skeleton of *S. Aquaticus*.



Fig. 7. — $\frac{16}{16}$ Skeleton of *S. Aquaticus*, showing fore-part of body the 14 pr. ribs, long shoulder blades, and back teeth.

being 5.75 inches in the flesh); skull, 1.31 inches; the tail (8 caudal vertebra bones), 1.25 inches; there are fourteen pairs or twenty-eight ribs.

The skull (Fig. 8), measurements, 1.31 inches length, .69 inch maximum width), has the openings for nasal passages in end of nose portion, which is slightly enlarged; there are no cavities for the eye balls. There are, however, several minute openings for the optical

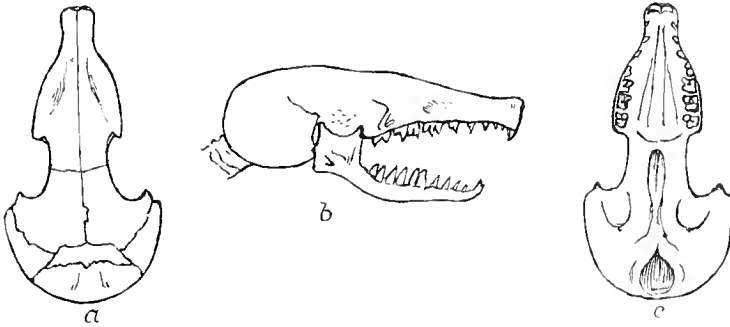


Fig. 8—¹⁶/₁₆ *Scalops Aquaticus*. a—Top of skull. b—Side view of skull, and lower jaw. c—Under side of skull.

nerves, etc., at the place on the skull where the eye cavity might be. The teeth in this specie number thirty-six in mature individuals, in immature and old adults one or both of the two pair of very small lateral teeth in the upper jaw are sometimes wanting, making the number thirty-four or thirty-two. Taking the teeth|| as a whole (Fig. 3 showing incisors, Fig. 7 side view of other teeth), their form would seem to preclude the idea of the mole being granivorous; there being strictly no true grinders, the molariform teeth in each half of both maxillary and mandibular groups being pentacuspoid. This, with the up-and-down or vertical motion of the lower jaw, being quite conclusive evidence of the cutting up of food, not grinding.

MISCELLANEOUS NOTES CONCERNING THIS MOLE AND THE FAMILY IN COMMON.

The male mole is quite pugnacious and when irritated it bites savagely and strikes quite a forcible blow with a backward motion of the fore arm and paw. Many specimens collected are much scarred about the head and muzzle, which scars were doubtless received during its numerous conflicts. For apparently its protection in these battles the skin on the breast is about twice as thick as on any other part of the body.

Owing to the peculiar position and construction of the fore leg and hand there is much lack of freedom in this member of locomotion, and so the running gait of this animal is far from graceful, being attended with much contortion of body. The mole runs far more

|| See Dentation of Mole by Spencer Bate, in Tran. Odontological Soc. (London) V, 1867, p. 261. And on the Dentation of the Mole, by H. N. Moseley and D. R. Lankester in Jour. of Anat. & Physi. 2d. Series No. III, Nov. 1868.

rapidly in their burrows than upon the surface of the ground, the position of the fore feet being such that they can take hold of the burrow's sides with so much greater ease than they can a surface beneath the body.

This particular species takes to water readily and swims with an ease and rapidity quite remarkable for an animal which is not distinctly amphibious, its actions in this element being such as to indicate that if its webbed hind feet are not indicative of its nature (as some naturalists assert), that at least the specie title, *S. Aquaticus*, which has been given it, is not altogether ambiguous.

Upon striking the water this mole immediately raises its muzzle until the nostrils are entirely above the water line, its body being sunk until the water's surface makes a line from the angle of the mouth to root of tail. It swims in a straight forward course, using only its hind feet for propulsion. The hind feet being dropped the full length of the leg and the toes widely distended (showing the use of web), it makes short but very rapid alternating strokes. The front feet, with palms outward, of course, are placed tightly against the sides of the head and are only used to change the direct line of its course, which is done by making a sharp, quick outward stroke of the digits alone, there seemingly not being the slightest wrist movement.

The mole usually makes its home in some hedge row or other piece of ground which is not cultivated; its nest, made of dried grass or leaves, is placed at the bottom of a burrow, ranging in depth from seven to fourteen inches, probably deeper in the winter season, the hole leading thereunto being round, smooth and sharply inclined towards the surface. From this main hole a second is made in an opposite direction, leaving the first just above the nest, thus forming a means of retreat in times of danger.

From this established home the mole makes its peculiar raised burrows in all directions, going out when hungry to the ends and pushing first one and then another branch farther as it "follows its nose" in its search for food. These raised tunnels (which afterwards become runways) are usually about two inches beneath the level of the ground, the top of the raised earth of the runways being about 3.5 inches above the bottom. The mole, when near the surface of the ground, burrows quite rapidly and when placed on top of the ground I have known it to bury itself, in moderately soft ground, in from three to five seconds. When food is scarce it will make over one hundred yards of raised tunnels in ten days. In making its burrows the mole, unlike any other burrowing animal, does not remove or cast out the earth from its burrows, but with its muzzle, when near the surface, it roots up the earth and passing beneath forms a raised tunnel-like runway or burrow. Should the mole sink its burrow to a depth of four or six inches, as it does during every

protracted dry and hot spell of weather in the summer, it then raises the surface of the ground so slightly that its burrowing operations are quite imperceptible. Should a sudden wet spell of weather at such a time set in, the mole at once following its insect food, comes towards the surface, and so it is that the mole is seemingly more numerous during a wet period of weather. It is likewise only when the burrow is being driven deeply as in dry weather and in the winter time, that the great muscular development in the fore arms, feet and neck of the mole comes into full use, for then the mole by packing of the earth upwards, with its muzzle and outward with its palms, literally shoves its way through the earth. The mole is strictly subterranean in its habits, never coming to the surface except to gather water, either from the blades of grass after a rain, or from the pools in gutters by the roadway, down the bank of which may frequently be seen its burrows leading to the water edge.

The food of the mole consists largely of earthworms, beetles and their larvae, grub worms, and other insectivorous matter, with possibly a very slight amount of vegetable* matter at times.

The mole is quite a voracious feeder and is seemingly capable of not only consuming large quantities of food, (many of the larger intestines examined containing an amount quite equal to one-half of a fluid ounce or about one tablespoonful; the smaller intestine, measuring 30.3 inches in length, has likewise quite a capacity for matter), at a time, but demanding its food frequently, and to suffer death from deprivation of food material for even a comparatively short period of time.

For instance, I have had individuals (which I had in confinement) to die within ten hours after having been fed plentifully with earthworms, with body much distorted, as if having died in much pain and upon examination of stomach I found intestines much constricted and entirely empty, there being only the slightest coloration of the mucous towards the terminal portion of the smaller intestines.

It was quite interesting to see the manner of the feeding† of the moles which I at different times had in confinement. Upon an earth worm being dropped into the place of its confinement it would raise its muzzle and waiving it to and fro would soon by its sense of

* See tabulated statement concerning food matter in stomachs, in Part II of this Report. Also results of examinations made by Prof. H. Gorman of Kentucky Agricultural Experimental Sta. as recorded in Seventh Annual Report of that Dept. on pages xli to xlv, year 1884; and Bulletin No. 61, p. 23, March 1896.

† It is not without much pleasure that I am enabled to add the corroborative evidence given by a letter of H. D. Moore, M. D., of Lexington, Somerset Co., which was received during this investigation, as follows: "I have seen the 'common' Mole feed on earthworms, and it is remarkable to see one strip the worm of its cast. If they happen to pick up the worm by the tail, they will quickly turn it, and taking the head in the mouth, draw the worm between the fore feet,—the feet or paws keeping up a rubbing motion,—which strips it of all its contents or cast. They do this very rapidly."

smell locate the exact position of the worm; then it would eagerly pounce upon the worm, seizing it with its teeth by the head, or near that portion, the mole would catch the worm between the third and fourth digit of one of its fore feet (usually the right one), and with the palm of the other foot placed flatly upon the worm, would keep up a rubbing motion on the worm's body (extending towards the terminal portion), all the while it was drawing the worm through the digits of the other foot and eating it. As was clearly the object, this process of rubbing and drawing stripped out of the digestive tubes of the worm much, if not all, the earthy matter upon which it chiefly subsists, which matter would be quite indigestible material for the stomach of a mole.

In feeding upon a beetle, for example a "June bug" (*Lachnosterna fusca*), after first biting it to disable it, the mole would place one front foot upon the beetle and tearing off the outer or hard wing cases, would then leisurely eat it, biting off portion after portion until consumed.

Genus—*Condylura*, (Illiger, 1811).*

Specie—*Condylura Cristata*, (Desmarest, 1819).||
"Star-Nosed" Mole.

†Sp. Ch. "Nose with a fringe of elongated caruncles encircling the end. Nostrils, circular, terminal. Tail nearly as long as the body, covered with hair. Auditory opening large. Teeth, 44. Color, brownish black."

Measurements. From specimen from Cumberland county, Pa., in collection of U. S. Museum. From tip of nose to eye, .66 inch; to ear, 1.22 inches; to root of tail, 3.98 inches; to end of tail (total length), 6.82 inches. Length of tail, 2.83 inches. Length of hand or fore foot, .74 inch; width, .45 inch. Length of hind foot, .90 inch.

‡Habitat. The northern part of the United States, from the Atlantic to the Pacific, and from New Brunswick and Southern Canada to the southern borders of Pennsylvania.

‡ The "Star-Nosed" or "Long-Tailed" mole has the general form of the moles in its thick-set and clumsy body, large palms or fore feet, etc. But having rather longer limbs and tail than other members of

* Illiger, C. —"Prodromus Systematis Mammalium &c.," Berlin, 1811, p. 125.

|| Desmarest, A. G. —"Jour de Physique LXXXIX," Paris, 1819, p. 230, &c.

† Baird, S. F. —"Mammals of U. S., Washington, 1857, p. 72, &c.

‡ Ib. p. 57.

† Other works seen, but not directly quoted:—R. Harlan, M. D. —*Fauna America* &c., Phila., 1825, p. 36. Dekay, J. E. —*Zoology of New York*, Albany, 1842, p. 12.

the mole family, it presents a rather more erect and less awkward an appearance. As in the "Common" mole, there is no distinction of neck, but the head tapers rapidly from the back part to end of the much depressed or attenuated snout. It is the muzzle (Fig. 9),

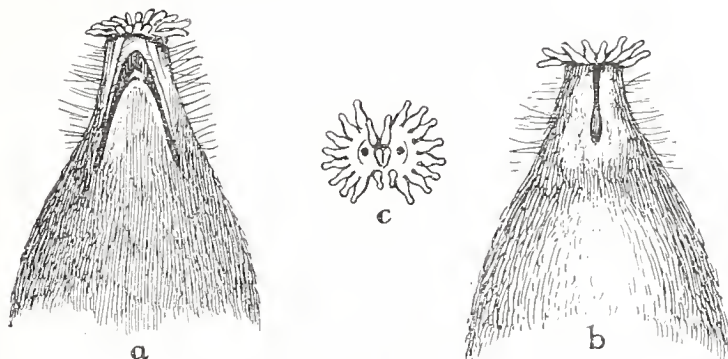


Fig. 9, $\frac{16}{16}$

Condylura cristata.—Star nosed mole.

a—Under part of muzzle; b—Upper part of muzzle; c—The star shaped formation on end of nose, as seen in front.

which gives this specie its marked and distinct individuality, and the utility of whose strange formation is quite a mystery. It is somewhat stouter than in the case of *S. aquaticus*, and unlike it, is truncated perpendicular to its length, the margin of which truncated portion is extended into twenty-two elongated or projecting points which are regularly arranged around the circumference, eleven on each side. These projecting growths vary but slightly in length, the lateral ones being the longest, about .20 inch. They spring directly from the margin of the nose, except the upper one on each side, which have their bases inside of the circumference of the margin. The whole formation gives the end of the muzzle quite a symmetrical, star-like form.

The nostrils of this specie resemble somewhat that of the European mole (*Talpa europæica*), in that they are circular and entirely terminal. They are in the central part of the nose and are separated by about one-tenth of an inch.

The whole terminal portion of the muzzle is free of hairs, including a narrow space behind the nasal projections on the upper surface of the snout. On the under surface of the muzzle there is a furrow very deep and short, reaching from the incisors to the tip of the nose. In fact, this furrow is formed by the coming together of two furrows, one on either side of the mouth, where they have separated the lips from the gums and teeth.

The eyes are very small, but can readily be seen. They have a distinct opening in the skin over the orbit, of about .05 of an inch in diameter. It is proportionally as large as in most species of the shrew family and doubtless serves a visual purpose. It is situated

about midway between the end of the nose and the centre of the ear opening.

Like other species of this family, the *C. cristata* has no external ear projecting above the surface of the skin, but the meatus is very large and is placed obliquely and nearly parallel with the top of the head. The opening is oval, about .30 of an inch in its longer diameter, about half as much the other diameter.

The general character of the ear, is, as in the short-tailed American shrew (for instance the *Blarina cinerea*, which is common in the southeastern part of Pennsylvania, especially in the fields of Chester county), with less development of auricle, however.

The hands are broad, but are not so large as in *S. aquaticus*, or the "common" mole. Owing to their scaly appearance they form a striking resemblance to those of terrapins. The hands are free of hairy growth, except on the back near the wrist, and in a slight encircling fringe along the edge of the palms, as in the "common" mole; the rest of the hand, including the whole of the under surface, and most of the upper, is closely covered with brown scales of nearly uniform size below, but larger near the outer margin above. (See Fig. 10,

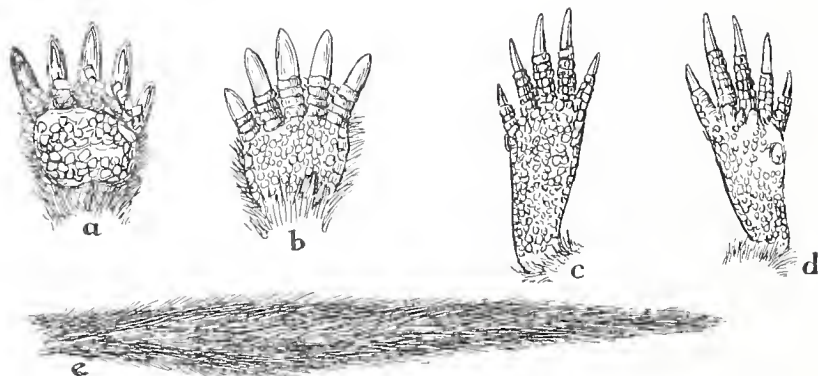


Fig. 10, $\frac{16}{16}$

Condylura Cristata—a—underpart of fore-foot, [left], b—top of fore-foot; c—top of hind-foot; d—sole of hind-foot; e—tail.

a b). The outer edge of the under surface of each of the anterior fingers is extended into three lacinated hard processes. The width of the palm is about half its length and the hand is slightly webbed between the basal phalanges. The whole appearance of the fore foot of this specie is very curious.

The hind feet, although narrower than the fore feet, are considerably longer, and the whole surface is similarly covered with the scaly formation seen on the fore feet. The scales are, however, somewhat smaller than those on fore feet. (Fig. 10, c, d.) There is a large horny tubercle on the inner edge of the sole, midway between the heel and the tip of the first claw; there are three other smaller

ones in a line at nearly equal distances, near the outer edge of the fingers. The claws in both feet decrease regularly from the fourth to the first; the outer claw is but little shorter than the fourth.

The tail is quite long in this specie, nearly as long as the body. It is covered with annulations of rather large, coarse scales which, however, are much obscured by the long, bristly hairs which spring from between them. The base of the tail is much constricted, but swells rapidly to the basal fourth and then tapers gently to the tip. (Fig. 10, e.) Usually the greatest diameter of the tail is about .20 of an inch, but during certain seasons of the year, by the deposition of fat under the skin, it swells to an enormous size, so as to exceed half an inch in thickness. Specimens vary much in the length of the tail, which appears to be longer in males than females.

The fur of this specie is much coarser than in the "common" mole, *S. aquaticus*, and without its lustrous gloss. It consists of two kinds of hair, a basal or body fur, with longer, coarser hairs, thickly interspersed, the longest measuring about .50 of an inch. The color is a uniform dark, sooty brown or blackish on back and sides with a barely distinguishable lighter shade on under parts of body.

This specie has 44 teeth, whose forms are totally different from the "common mole" in form.

Genus—*Scalops*.

Sub-genus—*Scapanus*. (Pomel, 1842.)*

Specie—*Scalops* (*Scapanus*) *Breweri*. (Bachman, 1841.)|| "Hairy-Tailed" Mole.

†Sp. ch. "Teeth, 44. Eyes covered by the integument. Ear-opening rather large. Nostril, lateral. Palm, narrow. Tail, densely hairy. Color, dark plumbeous, glossed with ashy brown."

Measurements. From tip of nose to incisor teeth, .35 inch; to eye, .75 inch; to ear, 1.15 inches; to root of tail, 4.00 inches; to end of hairs on tail (total length), 5.25 inches. Length of nose, .35 inch; of tail, 1.25 inches. Width of palm or fore foot, .55 inch; length, .72 inch; length of hind feet, .75 inch.

‡Habitat. "Connecticut, New York, New Jersey, Ohio" and Pennsylvania(?).

† The body, though thick and clumsy, is rather more slender than is *S. aquaticus*. The head is rather pointed and elongated, owing to the great developement of the muzzle; this projects about .35 of an

* Pomel, A.—"Bulletin de la Geologie de France", 1849, VI.

|| Bachman, John—*Proc. of Boston Soc. of Nat. History*, 1841, p. 41.

+ Baird, S. F.—"Mammals of U. S." Washington, 1857, p. 68.

† Ib. p. XXXIII.

inch beyond the incisors, or rather more than the distance from the incisors to the angle of the mouth.

The snout (Fig. 11, a and b), is long and slender, somewhat depressed, and tapering to a rounded truncated tip. It is almost en-

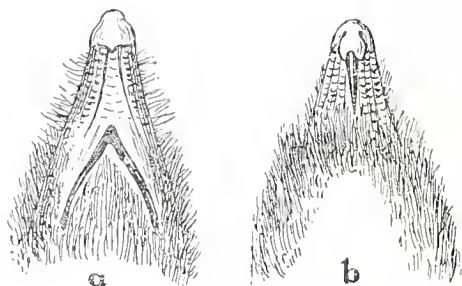


Fig. 11, $\frac{16}{16}$

Scalops breveri.—Hairy tailed mole.
a—Under part of muzzle. b—Upper part
of muzzle.

tirely naked above, and has but few scattered hairs on lower part of sides and beneath. There is a broad groove on the under side from the incisors to the bulb or gland of the nose.

The nostrils open on the sides of the terminal bulb, a little obliquely, so as to be slightly visible from above, but not from beneath.

The eye is excessively minute and covered with skin; it is situated a little posterior to the angle of the mouth and midway between the tip of the snout and the occiput.

There is no external ear; the meatus is an oval cavity, about one-twelfth of an inch in diameter, situated just above the insertion of the arm.

The palms (Fig. 12), are about as broad as long, exclusive of the claw, and are much smaller than in any other American specie; the

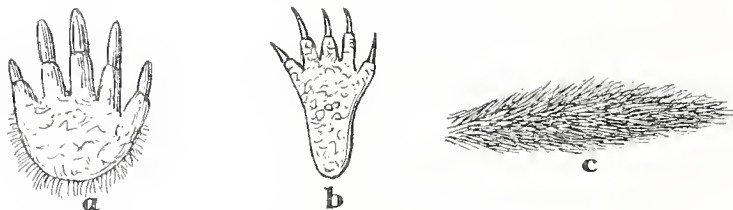


Fig. 12, $\frac{16}{16}$

Scalops breveri. a—Sole of fore-foot; b—sole of hind foot; c—tail.

under surface is entirely naked, with the posterior and lateral margins provided with a border of short, stiff hairs; the upper surface is very scantily coated; the claws are quite long, however, the third being the longest, the second being about as long, but owing to the

digit it does not project as far; the fourth a little shorter and smaller; the first and fifth nearly the same size, the first, however, being slightly longer.

The hind foot (Fig. 12), is about as long as the fore, much narrower and weaker; however the relative proportion of the toes and claws much as in the fore feet. And like the fore foot, naked beneath, and upper with scanty hairs. The toes in this specimen much cleft, even to the penultimate articulation.

The tail is thick and blunt at the end, entirely and densely covered with bristly hairs; about .15 inch long; it is slightly constricted at the base.

The color of the fur, which is long and full and not nearly so soft as on *S. aquaticus*, is of a dark ashy plumbeous color, glossed with ashy brown. One of the species characteristics of this mole is its having 44 teeth, several of which much resemble those of the *Talpa europaea*, or European mole.

PART II.

THE ECONOMIC RELATION OF THE MOLE TO AGRICULTURE.

AN INVESTIGATION CONCERNING THE FOOD OF THE MOLE.

There seems to be a widely diffused idea which is receiving much belief, of late years, by those especially who are engaged in the occupation of agriculture, that the mole is not only not beneficial, but positively injurious to the agriculturist, that it not only does much injury to vegetation in general, and to young plants in particular, by the rooting up and loosening of the soil about the plants while making its under ground passageways in its search for food, but that it eats seed grains which have been sown or placed in the ground, that it eats the small fibrous roots of our grasses and grains, and especially by gnawing does much damage to roots of a tuberous nature, such as potatoes.

I am disposed to believe that all damages done by the eating of grain seeds and fibrous roots and by the gnawing of roots of a tuberous nature are entirely due to the ravages of the mouse family (*Arvicolinac.*)

As a matter of fact the runways of the mole are taken possession of and occupied during the latter part of the summer and autumn season by the common brown "field" or "meadow" mouse, (*Arvicola riparia*, Ord., 1825).

This mouse, which undoubtedly does the most extensive damage, to vegetation, of any of our mammaliae (being not only granivorous, but herbivorous), makes its nest, during the early part of the warm season, on the surface of the ground in the middle of a luxuriant bunch of grass or other vegetation of a close and dense nature, from which home it makes its runways or paths in all directions (cutting and eating the vegetation clear for a width of from 1.50 to 2.0 inches in order to make these paths.) When the vegetation is taken from the fields during the harvesting of crops, or so closely cropped by the grazing of the cattle, as to offer but scanty hiding places from its natural enemies (the hawk and the owl, the fox and the skunk), this mouse takes up its habitation under brush piles, "worm" fences and rocks, or in stone piles and the underground runways of the mole. The latter it somewhat modifies for its own use and convenience by

cutting openings therein every two or three feet of length. The mouse, having thus become domiciled, follows the runways in all their ramifications, and as the mole in its search for food has driven these underground passages in those places where insect life is most prolific, amidst the densest vegetation, so the mouse, following thereafter, has supplied, with little trouble to itself, the vegetable food it so desires.

It was for the positive evidence wanted on this matter of the food supply of the mole that the present investigation was inaugurated; that specimens of moles were gathered and stomach examinations were made. The result of which examinations is shown in detail in the following tabulated statement:

A tabulated statement showing the distribution of the mole through the State of Penna.

No.	Date Collected, 1896.	Species, Sex, Age.	Measurements.	Locality.	Ground Taken From.	Condition of Stomach and Contents.
1	June 19,	<i>S. aquaticus</i> , *ad.,	Total 5.5 inches, nose .40 inches, tail .75 inches.	Cochranville, Chester co.	Killed in plant bed.	Stomach about half full—many fragments of banded earthworm (<i>allophophora foetida</i>), 1 intestinal worm, parasite, $\frac{1}{15}$ inches long.
2	June 20,	<i>S. aquaticus</i> , *ad.,	Total 5.25 inches, nose .40 inches, tail 1 inch.	Highland, Chester co.,	Killed in old grass sod.	Stomach much distended—8 large banded earthworms; 2 pupae in cases not determined, food but little masticated.
3	June 24,	<i>S. aquaticus</i> , *ad.,	Total 6 inches, nose .45 inches, tail 1 inch.	Highland, Chester co.,	Killed in kitchen garden.	Larger intestine entirely empty—smaller intestine contained much earthy matter, as from digestive tubes of earthworms, 1 parasite worm was attached to wall of larger intestine.
4	June 27,	<i>S. aquaticus</i> , †ad.,	Total 6 inches, nose .45 inches, tail .87 inches.	Cochranville, Chester co.	Killed in truck grounds of a florist.	Stomach only about half full—entire contents earthworms, much masticated.
5	July 4,	<i>S. aquaticus</i> , †ad.,	Total 6 inches, nose .45 inches, tail .87 inches.	Cochranville, Chester co.	Killed in truck grounds of a florist.	Stomach nearly empty—a few fragments of earthworms (specimen much decomposed).
6	July 8,	<i>S. aquaticus</i> , †ad.,	Total 5.75 inches, nose .40 inches, tail .87 inches.	Highland, Chester co.,	Killed in bank of road side.	Stomach nearly empty—containing fragments of an earthworm; a gray spider with its brown egg case; fragments of wing, 1 leg and several leg fragments, part of jaw, and 3 fragments the black and yellow banded portion of stomach of the sand hill hornet (<i>stizus speciosus</i>). This mole had apparently came upon a sand hill or ground hornet in its home and had eaten not only it, but the food which it had laid up for its larva. I have several times seen both angle or earthworms and spiders with the locust in the burrow nest of this insect.
7	July 10,	<i>S. aquaticus</i> , †ad.,	Total 6 inches, nose .43 inches, tail .87 inches.	Highland, Chester co.,	Killed in grass plat.	Stomach full—many fragments of banded earthworm; 61 larva of ant mire (large, red); fragments of brown wings, etc. (of insects not determinable.)
8	July 25,	<i>S. aquaticus</i> , *ad.,	Total 5.5 inches, nose .40 inches, tail .75 inches.	Highland, Chester co.,	Old orchard.	Stomach nearly empty—2 bodies of grub worms (which usually frequents decayed roots), the larva of the spotted grape vine bug (<i>Pelidnota punctata</i>); 6 thread worm parasites, in larger intestine.
9	Aug. 5,	<i>S. aquaticus</i> , *ad.,	Total 6 inches, nose .43 inches, tail .87 inches.	Highland, Chester co.,	Killed in grass plat.	Stomach quite empty—1 wire worm, the immature elateridae or "snapping bug."
10	Aug. 18,	<i>S. aquaticus</i> , *ad.,	Total 5.5 inches, nose .40 inches, tail, 1 inch.	Highland, Chester co.,	Killed in road way.	Stomach quite empty—2 small fragments of earthworms.
11	Aug. 29,	<i>S. aquaticus</i> , †ad.,	Total 6.37 inches, nose .43 inches, tail 1 inch.	Highland, Chester co.,	Killed in potatoe patch.	Stomach nearly empty—"many fragments of brown wing cases, legs, etc., of (probably 2 specimens) <i>Lachnosterna fraterna</i> ." 17

12	Sep.	1.	S. aquaticus, ♀ad.,	Total 6.25 inches, nose .43 inches, tail .87 inches.	Highland, Chester co.,	Killed in old sod...	Stomach nearly empty—a few fragments of earthworms; 1 body of white earth grub, the larva of brown 'June' bug. (Lachnosterna fusca.)
13	Sep.	18.	S. aquaticus, ♀ad.,	Total 6 inches, nose .40 inches, tail 1 inch.	Highland, Chester co.,	Killed in old sod...	Stomach quite full—many fragments of (prob. 4) earthworms; 6 white earth grubs, larvae of 'June' bug, or Lachnosterna fusca.
14	Sep.	21.	S. aquaticus, ♀ad.,	Total 6.25 inches, nose .43 inches, tail 1 inch.	West Chester, Chester co.,		Stomach well supplied—3 grubs, 'larvae of Carabus beetle'; and 6 fragments about .25 inches in length, of "monocotyledonous leaf tissue (grain)." 18
15	Oct.	2.	S. aquaticus, ♀ad.,	Total 6 inches, nose, .43 inches, tail 1 inch.	Highland, Chester co.,	Killed in old sod...	Larger intestine entirely empty—smaller intestines, contained fragments of earthworms, and earthy matter.
16	Oct.	2.	S. aquaticus, ♀ad.,	Total 6 inches, nose .37 inches, tail .87 inches.	West Chester, Chester co.,		Stomach well supplied—many fragments of earthworms (prob. 5 individuals). one fragment was entangled in a section of very fine root, which being unwrapped measured 1.25 inches, also a fragment of dead grass leaf tissue 1 inch long.
17	Oct.	5.	S. aquaticus, ♀ad.,	Total 6 inches, nose .43 inches, tail .87 inches.	Highland, Chester co.,		Stomach well supplied—many fragments of banded earthworm (3 specimens); 1 white grub, larvae of Lachnosterna fusca.
18	Oct.	5.	S. aquaticus, ♀ad.,	Total 6.25 inches, nose .43 inches, tail .87 inches.	Highland, Chester co.,	Killed in ground beneath corn shock.	Stomach well supplied—fragments of grain of green corn. (prob. most of one grain); fragments of "a specimen of one of the May beetles known as Lachnosterna hirticula." 19
19	Oct.	15.	S. aquaticus, ♀ad.,	Total 5.5 inches, nose .37 inches, tail .89 inches.	Highland, Chester co.,	Killed in corn field.	Stomach nearly empty—I very large banded earthworm; some earthy matter.
20	Oct.	21.	S. aquaticus, ♀ad.,	Total 6.5 inches, nose .35 inches, tail .95 inches.	Villanova, Delaware co.,		Larger intestine entirely empty—smaller intestine contained some earthy matter and fragments of brown insects, all however so much decomposed as to be indeterminate.
21	Oct.	21.	S. aquaticus, ♀ad.,	Total 6.63 inches, nose .43 inches, tail .87 inches.	Villanova, Delaware co.,		Stomach very full—6 large earthworms (in large fragments); 1 white grub; fragments of brown wing case, etc., of (prob. L. fraterna) beetle; 2 small fragments of dead grass leaf tissue.
22	Oct.	21.	S. aquaticus, *ad.,	Total 6 inches, nose .37 inches, tail .75 inches.	Villanova, Delaware co.,		Stomach well supplied—prob. 3 earthworms, fragments of brown legs, wing cases, etc., of beetle, not identified; 3 fragments of dead grass leaf, one was 1.25 inches long.
23	Oct.	21.	S. aquaticus, *ad.,	Total 5.75 inches, nose .40 inches, tail .75 inches.	Highland, Chester co., Pa.	Killed in corn field.	Stomach nearly empty—I large banded earthworm; 1 white thread worm or intestinal parasite.
24	Oct.	24.	S. aquaticus, ♀ad.,	Total 6.125 inches, nose .375 inches, tail 1 inch.	Highland, Chester co., Pa.	Killed by road side.	Stomach well supplied—"contained vegetable matter (probably chewed roots); earth worms, remains of Coleopterous insects, such as heads, legs and elytra. they prob. belong to the family staphylinidae; also one pupa case of a Dipterous insect," 1 intestinal worm. 20
25	Oct.	27.	S. aquaticus, ♀ad.,	Total 6.875 inches, nose .40 inches, tail 1 inch.	New Hope, Bucks co., Pa.		Larger intestine entirely empty, smaller intestine contained nothing but some indigestible matter which apparently was "vegetable matter of same character as 'No. 24,' above; and also a pupa-case of a dipterous insect," this specimen much decomposed. 21

Tabulated Statement—Continued.

No.	Date Collected. 1896.	Species, Sex, Age.	Measurements.	Locality.	Ground Taken From.	Condition of Stomach and Contents.
26	Oct. 30,	<i>S. aquaticus</i> , ♀ad.,	Total 6.62 inches, nose .40 inches, tail .75 inches.	Villanova, co., Pa.		Stomach well supplied—contents 3 earthworms, 1 fragment of dead grass leaf tissue (.25 inches long); 1 larva of a carrion beetle belonging to the genus <i>Sylpha</i> , together with 2 cocoons of same whole." ²²
27	Oct. 30,	<i>S. aquaticus</i> , *ad.,	Total 6.56 inches, nose .45 inches, tail .875 inches.	Villanova, co., Pa.		Stomach well filled—contents, 1 earthworm, 1 small fiber of root (.375 inches long); many fragments of legs, heads, etc., of prob. same beetle <i>Sylpha</i> , this stomach's contents being al- most identical to "No. 28."
28	Oct. 30,	<i>S. aquaticus</i> , ♀ad.,	Total 6.375 inches, nose .45 inches, tail .75 inches.	Villanova, co., Pa.		Stomach very much distended, contents, 9 earth- worms, some fragments of "bugs" (not deter- mined) 5 pupa cases and much earthy matter.
29	Oct. 30,	<i>S. aquaticus</i> , ♀ad.,	Total 6.375 inches, nose .40 inches, tail .75 inches.	Villanova, co., Pa.		Stomach well supplied and "contained several hun- dred heads, and legs of the adult beetle <i>Sylpha</i> , (probably opuca) and the anal ends of four earth- worms; together with a number of parasites." ²³
30	Oct. 31,	<i>S. aquaticus</i> , *ad.,	Total 6 inches, nose .375 inches, tail .875 inches.	Highland, Chester co., Pa.	Killed in sod on lawn.	Stomach nearly empty—2 small fragments of earth- worms, and fragments of the May beetle, usually called "June bug."
31	Nov. 17,	<i>S. aquaticus</i> , *ad.,	Total 6 inches, nose .40 inches, tail .875 inches.	Highland, Chester co., Pa.	Killed in sod on lawn.	Stomach well supplied—3 earthworms, two white grubs (larva of May beetle), fragments of ap- parently, the brown millipede, <i>Cambala an- nulatata</i> , many fragments of brown beetle frag- ments, apparently the May beetle or June bug.
32	Dec. 12,	<i>S. aquaticus</i> , ♀ad.,	Total 6 inches, nose .40 inches, tail .875 inches.	Highland, Chester co., Pa.	Killed on truck farm.	Stomach nearly empty—some slight fragments of earthworms, and a flake like fragment of mica schist (this fragment of mineral was .19 inches in diameter).
33	Feb. 1, 1897.	<i>S. aquaticus</i> , ♀ad.,	Total 6.25 inches, nose .44 inches, tail .75 inches.	Highland, Chester co., Pa.	Killed in old or- chard.	Stomach very full—containing multitudinous frag- ments of brownish black beetles, apparently of the family carabidae or ground beetle, a care- ful examination of fragments of jaws and an- tennae, resulted in identifying apparently, the beetle, <i>Calosoma scrutator</i> , as having been taken. The smaller intestine contained two intestinal parasites of tape worm family.
34	Sept. 18,	<i>S. aquaticus</i> , ♀ad.,	Total 6 inches, nose .375 inches tail, .875 inches.	Highland, Chester co., Pa.	Killed in corn field.	Larger intestine quite empty, smaller intestine well filled with brown fragments of beetles, called click beetles or Elateridae together with fragments of pupa and cells of apparently this same insect.

35	Sept. 23,	<i>S. aquaticus</i> , ♀ ad.,	Total 6.6 inches, nose — inches, tail 1 inch.	Highland, Chester co., Pa.	Killed in field.	in corn	Both intestines very full—3 earthworms and much earthy matter; vast amount of fragments of the ancestor of the wire worm, the click beetle; 2 fragments of a fibrous root, similar to corn roots (.33 inches and .50 inches). Stomach quite well filled—many fragments of earthworms (6 anal ends being determined); 1 white grub worm, apparently the larva of the May beetle.
36	Oct. 13,	<i>S. aquaticus</i> , ♀ ad.,	Total 6.25 inches, nose .44 inches, tail .90 inches.	Highland, Chester co., Pa.	Killed in field.	in corn	

†Male. *Female.

17 Insect matter of stomach No. 11 identified by the kindness of L. O. Howard, Entomologist, United States Department of Agriculture, Washington, D. C.
 18 Contents of stomach No. 14, kindly identified by Prof. R. C. Schiedt, Entomologist, Pennsylvania Department of Agriculture, Franklin and Marshall College, Lancaster, Pa.
 19 Contents of stomach No. 18, kindly identified by L. O. Howard, Entomologist, United States Department of Agriculture, Washington, D. C.
 20 and 21 Contents of stomachs No. 24 and No. 25, kindly identified by Dr. Henry Skinner, Entomologist, Pennsylvania Department of Agriculture and Prof. Ent. Acad. Nat. Sci., Philadelphia, Pa.
 22 and 23 Contents of stomachs No. 26 and 29, kindly identified by Prof. R. C. Schiedt, State Entomologist, Department of Agriculture, Franklin and Marshall College, Lancaster, Pa.

Of the thirty-six (36) specimens gathered and examined, as herein detailed, all (except one, the stomach of which was entirely empty), contained animal matter, as follows: Twenty-seven had eaten earth-worms, in connection with other matter; seven (7) had eaten earth-worms alone; twenty-seven (27) had eaten insect life in it various stages of existence; nine (9) had eaten insects alone. Ten (10) individuals had taken into their stomachs vegetable matter in connection with insect food. None had, however, taken vegetable matter alone. Of the specimens whose stomachs contained vegetable matter, all (where there was the slightest doubt of its existence, as in Nos. 24 and 25, or the contents seemed to be of such importance as to warrant the having of the most positive evidence, as in Nos. 14 and 18), were submitted to specialists, as above named, whose reports on stomachs, so kindly given, are noted and now gratefully acknowledged, since they add very materially to the value of the examination.

I desire to say that I believe only specimens No. 14 and 18 are of any great importance in relation to the vegetable matter found in the above examinations of stomach. No. 14 having six (6) fragments of green leaf tissue of grass or grain; each fragment was about .25 of an inch long and had clearly been bitten off piece by piece. No. 18 contained the amount, I should think of a whole grain of corn, which was quite coarsely broken up. All other vegetable matter was of dead grass leaf tissue, showing no teeth cutting and were such fragments as might easily have been taken in the mouth with the food which the mole devours so voraciously. The evidence given by the examination of the stomach of specimen No. 16, showing quite conclusively, I think, how the vegetable matter came into the stomach of this individual, at least.

In short, in my mind, the data furnished by the above examination of contents of stomach (barring the evidence given otherwise by Nos. 14 and 18,* which might be accounted for), would seem to acquit the mole of the charge of taking vegetable matter into its stomach, intentionally, for food.

And that my conclusion—that the mole is strictly an insectivorous animal—is substantiated, as previously stated, on its dentation; upon the evidence furnished by the examination of major part of stomachs (which evidence is, of a matter of fact, subject to modification and might be either strengthened or weakened by other investigators), of the general use of insectivorous matter for food; and that no specimen has been recorded of an individual having eaten nothing but vegetable matter; and upon the negative yet quite con-

* Of this stomach's contents Prof. Howard of U. S. Dept. of Agriculture says by letter dated Oct. 10, 1896: "Inasmuch as this May beetle [*Lachnosterna hirticula*] is itself a feeder on vegetation it will be difficult to say whether any vegetable matter found in the stomach of the mole [No. 18] was eaten by the mole directly or not."

clusive argument so well stated by Prof. Garman, that || "Living as the mole does among the roots of plants, there is no reason why it should not devour vegetable food in large quantities, if it felt so disposed. Insects and worms are generally much more difficult to obtain, yet the greater proportion of the food consists of animal matter. I think we can draw only one conclusion from this fact, which is, that the American mole, like its European cousin, is an 'insectivorous' animal. Its peculiar habit of burrowing among the roots of grasses and other plants, where it must often seize quickly prey liable to escape will account satisfactorily for the presence of small fragments of vegetable tissue in its stomach."

My conclusion, in final, is that, proving the mole to be an "insectivorous" mammalian, is likewise proving its life work to be beneficial to the agriculturist. Since the vast amount of insect life taken as food by the mole, the larger part† of it consists of insects whose whole existence is deleterious to plant life, they being vegetation eaters and destroyers. And that the annoyance caused by the mole by its burrowing under and disturbing the root of growing plants, while in quest of food, is more than compensated by its destroying and removing therefrom the insect life feeding upon the vitality of these plants.

NOTES ON METHODS OF PREVENTING THE "WORKING;" AND ON THE EXTERMINATION OF THE MOLE.

During the progress of this investigation, many inquiries have been made of me for some method of exterminating the mole. While I believe that a false impression is rife concerning the economic status of the mole and its value to the agriculturist and that ordinarily it should be protected, yet I can quite readily see that when it "works" in well kept lawns, flower or plant beds, or among small truck and vegetables, the annoyance caused thereby makes it sometimes desirable to get rid of it, or at least to prevent its "working" in these places, and so some attention has been paid to this part of the subject. Of the methods of preventing the "working" of the mole in places where its burrows are not desirable, the following are submitted:

The surest method of preventing the mole from burrowing in any

|| See Seventh Annual Report of Kentucky Experimental Sta. Year 1894. Lexington, Ky., & p. XLIII c. Prof. Garman's Report "The Food of the Common Mole".

† The exception being made for those insects, individual member of which were found in the stomach's of the mole, belonging to the family of those scavengers beetles known collectively as Carrion beetles; and for the family of ground beetles [*Carhidæ*] "which prey on those insects largely injurious to crops." [See "*Our Common Insects*" by A. S. Packard, Salem, 1873, p. 191]; and also the earthworm, whose operations are considered by scientists to be of undoubted benefit to vegetation [By Darwin,— in facilitating drainage; by Prof. Wollny,— in cultivation of roots.

particular locality is to "starve it out." The food material, as we have seen, of the mole is insectivorous, it can readily be understood that could we but remove the insect from our soil, the mole would die of starvation or be forced to seek a new habitation and field for its operations. Thus it may be seen that a direct attack on the insect would be an indirect assault against the mole.

However, how to banish the insect life from our soil is quite "another story." With the rapid denudation of our wooded land, and the opening up to cultivation of the waste acres on the farm, the insect life which in the past has found a natural food in the foliage of the forest trees, and the vegetation of the uncultivated acres, turns for food to the plant life under cultivation by the husbandman. Thus insect life (having changed its habitat) is seemingly on the increase, and is brought more and more in prominence to the horticulturist and farmer as year by year it makes more substitutions for its natural food.

However the early recognition of the fact that the disposition of insect life is a problem which farmers must meet and study, and not ignore as in the past; after which the gaining of a thorough knowledge of the insect life about us, so we may know which are our friends, how to use and hold them in check; and which are our enemies, and how to destroy them; will enable us, I think, to cope quite successfully with this difficulty. It would be well, for all our farmers to have a copy of the little book **"Insects and Insecticides,"* and peruse its contents carefully, adding original thought to the suggestions therein given; to make a study of the economic relation of the animals about him to agriculture, and to protect as much as possible those birds and mammals which are trying to help him. It has been frequently brought before me that a liberal application of potash or of land salt sown over the ground would not only be a direct attack against the insect world, but might act as a remedy to the annoyances caused by the mole. In reference to this I desire to submit the following extract from a letter dated September 17, 1896, written by Mr. Joseph E. Gillingham, of Philadelphia, which is as follows: "At the suggestion of the managers of the Zoological Society we sowed about two hundred pounds of salt on our lawns and think it killed or drove away the worms upon which the moles feed, and in consequence we had not nearly so many."

I have somewhere read that truck raisers in Europe, when they desire to prevent the operations of the mole (*Talpa europaea*) from being continued further in any particular direction, place fragments of salt mackerel (or any other kind of fish which has been in brine), in the beginning of the runways leading in the direction objected to.

* A book recommended for the Chautauqua course of home reading by the Faculty of State College, by C. M. Weed, Orange, Judd & Co., New York.

The mole at once abandons altogether that burrow and sometimes even that immediate vicinity.

This method I did not try, and so I am pleased to have to submit the following corroborative evidence concerning it which has been kindly given me by a letter dated October 7, 1896, in which Mr. Elwood H. Darlington, of E. Bradford, Chester county, writes: "I know by test that shredded cod-fish placed in runways in a few places in garden will keep both kinds of moles away."

I have tried the method of saturating a bunch of rags or cotton with mineral pitch, or gas tar, and placing this in the runways. It was in every case a complete preventative of a continued use of such treated runways, and so I can recommend this method as a cheap and efficient one.

Of the methods of exterminating the mole, the following are submitted:

If one has plenty of time at their disposal, and does not care for a very exhausting exercise or physical exertion, perhaps one of the surest methods of extermination is to watch (from about 4 p. m. o'clock to twilight), the burrows or runways and when(?) you see the mole "working" or making an extension thereto, to thrust a spade down across the burrow, about a foot back of where the mole is "working," thus preventing its running back and eluding you; then with a hoe, a pointed stick, or even your finger, tear open the top of the runway and throw the mole out and dispatch it.

There are, however, upon the market several makes of mole traps, ranging in price from 75 cents to \$2.50, any of which will give satisfaction if properly set. However, that make of mole traps which has an upright frame work, with a double harpoon, which drops on either side when the trigger pan is raised, gives the best satisfaction to its users. This trap is set across the runway, which must be pressed down level at this place with the surrounding ground, the pan of the trigger arrangement of the trap is placed directly on this leveled portion of the runway; the mole coming to this place in his runway and in attempting to again raise the sod, raises the trigger pan of the trap, thus freeing the harpoon which, plunging downward through the light earth covering into the runway, one on each side of the pan, pierces the mole and thus kills it.

The poison, bi-sulphide of carbon, so extensively used in the "West" for the extermination of the gopher, ground squirrel and other burrowing mammals of that region, and whose use for this purpose was suggested to me by T. S. Palmer, Acting Chief of Division of Biological Survey, U. S. Department of Agriculture, was tried, not however, with as much success with the mole as with some other animals which have a close and smooth burrow. I found it useful in the extermination of the ground hog (*Arctomys monax*) and the

skunk (*Mephitis mephitis*). For the use of bi-sulphide of carbon the following method is recommended: Wrap a piece of cotton, about the size of a walnut, around a small twig, dip this into the liquid and, making a small opening into the side of the runway, push the stick, with its soaked wrapping into the runway and cover up the opening with a piece of sod. Do this about every ten feet of runways. As the object is to get the saturated cotton in the vicinity of the home burrow (in which case but one such saturated piece would be required), a far more economic way of procedure is to press down the raised runway with your foot at various points along its course, doing this say in the evening. In the morning treat that part of the runway which shows by the raising of the top that it is the living portion (or at least near to the nest burrow), with the poison as above described.

The liquid bi-sulphide of carbon evaporates very rapidly in warm weather into a deadly gas, which quickly permeating to the lowest parts of the burrow, (its specific gravity being denser than air), suffocates any living animal which inhales its fumes. By experiment I was enabled to asphyxiate in a closed burrow a mole beyond subsequent recovery in three seconds. The only failure of this substance being in placing it in a position where the gas generating therefrom cannot reach the nest burrow and its inhabitant.

Bi-sulphide of carbon can be purchased of any wholesale druggist in quart cans ($2\frac{1}{2}$ pounds), at about 60 cents per can; as a piece of cotton of the size above stated will only absorb one-fourth of an ounce this method may be seen to be one of the cheapest for extermination of not only the mole, but other mammals whose presence we do not think desirable.

One other method of extermination, I think, is of sufficient value to include herein. It is to poison thin small strips of fresh meat, preferably beef, with arsenic and place them in the runways; since the mole is carnivorous, this method will be found to be the only one in which a food material will be of any utility.

Several other methods have been suggested for the extermination of the mole, but enough has been already written to show that its extinction may be made a small matter, should one be so disposed.

DISTRIBUTION OF THE MOLE IN PENNSYLVANIA.

The following tabulated statement of the distribution of the mole in Pennsylvania, which is a summary of the answers received to an open circular sent into every county of the State, and which was expected to not only show the general distribution of the mole, but to elicit the opinion held concerning its value to the agriculturist, and if possible to gather from a comparison of the reports from the mountainous regions and the comparative low land districts of river valleyed counties, which of the two species (*S. aquaticus* or *C. cristata*)

was the most given to frequenting banks of large creeks and rivers, this being rather a disputed question.

That the result of this part of the investigation was only partially successful may in a measure be accounted for by the fact that of over one hundred and twenty-five open circulars sent out, only about forty returned filled out. The returned circulars were, however, quite interesting and showed the *S. aquaticus* the common mole, *C. cristata* being quite rare.

County.	Correspondent.	Address.	Is the mole (S. aquaticus) found in your vicinity or county?	Does it frequent meadow or bottom land or upland and hillside?	Do you consider it injurious to growing crops? In what way?
Bedford,	S. S. Diehl,	Bedford, Pa.,	Rare,	Upland,	In some localities it takes the bark from young apple.
Blair,	Frederick Jackel,	Altoona, Pa.,	Very rarely, I have not seen more than 4 in 20 years.	Meadow and bottom land.	No.
Blair,	Martin Herzog,	Tyrone, Pa.,	Are not,	Both,	Potatoes and corn, they undermining the roots.
Bradford,	W. F. Dittrich,	Towanda, Pa.,	Yes, common,	Both,	No.
Bucks,	Eastburn Reeder,	New Hope, Pa.,	It is, too numerous,	More common in bottom lands.	Injurious to grass in the fields.
Bucks,	Wilson S. Paxson,	Lumberville, Pa.,	Yes, very common, .....	.....	Injures strawberries, potatoes, etc., by raising up roots.
Centre,	H. T. Fernald, Professor Zoology,	State College, Pa.,	Vicinity, no, county? .....	.....	Undermining grass roots.
Chester,	Alfred Sharpless,	West Chester, Pa.,	Yes, numerous,	All farm lands,	It is troublesome and spoils the looks of lawns.
Chester,	E. H. Darlington,	West Chester, Pa.,	Yes, numerous,	Does not haunt hillside, but likes tilled lowland.	By the destruction of earthworms.
Chester,	Hon. T. J. Phillips,	Atglen, Pa.,	Yes, numerous,	The latter,	Injures grass roots, by burrowing under them.
Clarion,	Wm. Shanafelt,	Clarion, Pa.,	Yes, not plenty,	Mostly in old meadows.	By burrows in under the grass.
Clarion,	Prof. Thomas, S. N. S.,	Clarion, Pa.,	Yes, hardly common,	Both, but mostly low,	Not very.
Clinton,	J. A. Herr,	Cedar Springs,	Yes, rare in vicinity,	Meadow, generally,	Not to my knowledge.
Dauphin,	W. F. Rutherford,	Harrisburg, Pa.,	Yes, rare,	River bottom land,	Only by the mechanical action while making its burrows.
Delaware,	Theo. D. Rand,	Radnor, Pa.,	Yes, numerous,	All, I believe, certainly upland.	.....
Delaware,	Wm. W. Montgomery,	Radnor, Pa.,	Yes, very numerous,	Chiefly upland,	Yes, to grass land, the soil left around grass roots will not hold enough moisture.
Delaware,	Prof. P. P. Calvert, Professor in University of Pennsylvania,	Rutledge, Pa.,	Common, in Ridley Twp.	.....	Grass by burrowing at roots.
Delaware,	J. E. Gillingham,	Villanova, Pa.,	Numerous,	All,	Yes, to corn, strawberries, etc.
Erie,	J. C. Thornton,	Avonia, Pa.,	Yes, numerous,	Upland and lawns,	Does them no good.

County.	Correspondent.	Address.	Is the "common" mole (S. aquaticus) found in your vicinity or county?	Does it frequent meadow or bottom land or upland and hillside?	Do you consider it injurious to growing crops? In what way?
Huntingdon.	G. G. Hutchinson.	Warrior's Mark, Pa.	Yes, numerous.	Meadow and bottom land.	Grass, by its runways.
Juniata.	Matthew Rodgen.	Mexico, Pa.	Yes, rare.	Both.	Not serious, to clover, etc.
Lackawanna.	Geo. P. Fraint.	Scranton, Pa.	Yes, rare.	Meadow and bottom.	No.
Lancaster	Prof. R. C. Sehiadt, F. & M. College.	Lancaster, Pa.	Yes, common.	Generally bottom land.	No. I do, by the disturbance of roots.
Lancaster	W. H. Buller.	Marletta, Pa.	Yes, common in all parts of the county.	Both.	No. Does some damage.
Lancaster	Dr. M. W. Raub.	Lancaster, Pa.	Yes, rare.	I have mostly found it on the hillsides.	Such as it indirectly disturbs by its tunneling.
Monroe.	Randall Bishling.	Minsi, Pa.	Yes, rare.	Mostly bottom land.	No.
Montour.	J. K. Murray.	Pottsgrove, Pa.	Yes, abundant.	Frequents clover fields.	No.
Northumberland.	H. N. Conser, Ph. D.	Sunbury, Pa.	Yes, rare.	Found less abundantly in meadows than upland, avoids boggy ground.	No.
Northumberland.	James Van Klirk.	Pottsgrove, Pa.	Yes, common.	Both.	No.
Philadelphia.	S. N. Rhoads, Acad. Nat. Science, 28	Philadelphia, Pa.	Yes, numerous.	Both.	No.
Ilke.	Justin Nelis.	Edgemere, Pa.	Yes, common.	Both.	No.
Somerset.	H. D. Moore, M. D.	New Lexington, Pa.	Yes, numerous.	Most common on hillside.	No.
Sullivan.	Otto Behr.	Lopez, Pa.	Yes, rare.	Both.	Very little.
Tioga.	J. W. Mather.	Wellsboro, Pa.	Very rarely found.	Bottom land.	Not here.
Union.	Prof. Geo. G. Groff.	Lewisburg, Pa.	Yes, rare.	Bottom land.	Only when among tender plants and they happen to pass directly under.
Wayne.	B. U. Theo. Day.	Dyberry, Pa.	Yes, common.	Mostly on low lands, sometimes in woods.	Not much.
Wayne.	N. F. Underwood.	Lake Como, Pa.	Yes, numerous.	Both.	By making roads through roots.
Westmoreland.	M. N. Clark.	Claridge, Pa.	It is, quite plenty.	More plentiful in moist soil.	Injures roots of garden truck.
Wyoming.	N. G. Bunnell.	Vosberg, Pa.	It is, numerous.	Upland and hillsides.	
York.	Jno. L. Baer.	Delta, Pa.			

County.	Is the "star nosed" mole (<i>Condylura cristata</i>) found in your county or vicinity?	What kind of ground does it frequent, meadow or upland?	Have you any knowledge of its injuring any plant life?	Remarks Concerning Any Species of the Mole Family.
Bedford,	No.			
Blair,	Rare,	I found one along the river bank.	No.	
Blair,	Yes,	Both,	They destroy the roots,	Suggests, put a duty on their scalps.
Bradford,	Uncertain about it.			
Bucks,	Can't say.			
Bucks,	Have heard of them.			
Centre,	Yes, fairly common near streams.	Generally meadows,	No,	All moles are rather scarce here, there being no running water for several miles. Several times cases of "moles" reported to me have proved to be shrews.
Chester,	Yes, rare,	Mostly meadows,	No.	
Chester,	Yes, not plentiful,	Upland,		
Chester,	Yes,	Upland,		
Clarion,	It has been, rare,	Both,	No.	
Clarion,	Rare,	Both,	No.	
Clinton,	Yes, rare,	Meadow,	No. I have never known them to injure any of our garden truck.	In this section, moles completely honeycomb grass uplands, having a southern exposure. They seem to be more numerous in wet weather than dry, perhaps because they then go deeper.
Dauphin,	Yes, rare,			
Delaware,	Yes, rare,			
Delaware,	Yes, rather rare,	Meadow,	No.	
Delaware,	No, or rare,		By cutting grass roots and preventing them getting moisture from the ground.	
Erie,	Yes.			

County.	Is the "star-nosed" mole (<i>Condylura cristata</i>) found in your county or vicinity?	What kind of ground does it frequent, meadow or upland?	Have you any knowledge of its injuring any plant life?	Remarks Concerning Any Specie of the Mole Family.
Lackawanna,	Yes, rare,	Meadow, .....	.....	In the counties of Monroe and Northampton the common mole, is quite common, the star-nosed quite rare.
Lancaster,	I have never seen it here.	.....	.....
Lancaster,	Yes, rare,	Upland,	No,	Neither are common enough to cause any annoyance so far as I know in any of these counties, Northumberland, Union, Centre and Clinton, though such may be the case locally.
Lancaster,	Never found it.	.....	.....
Montour,	Have not seen it.	Upland,	None,	
Northumberland,	Yes, more "common," than the "common."	.....	.....	S. breweri is certainly likely to occur in Pennsylvania as we have a specimen from Vincetown, N. J.
Northumberland,	Yes, rare,	Low ground, .....	.....
Philadelphia,	Yes, not abundant,	Have found in upland lawns, but preferring wet ground along streams.	Only as stated for Scalops aquaticus.	I reside in the mountain region and have frequently seen the mole. I have not examined the specimens and therefore could not classify them.
Pike, .....	.....	.....	.....
Somerset,	Rare,	Both, .....	.....	The soil of Somerset county, being mixed with the shales and small stones of the barren and productive measures, makes it rather unfit for the habits of the mole. They are not very numerous, and it is not often I hear any complaint of them.
Sullivan,	Yes, common,	Low ground, .....	.....
Tioga,	Rare,	Upland, .....	.....

County.	Is the "star nosed" mole (<i>Condylura cristata</i>) found in your county or vicinity?	What kind of ground does it frequent, meadow or upland?	Have you any knowledge of its injuring any plant life?	Remarks Concerning Any Species of the Mole Family.
Union,	Rarely, .....	.....	No.	
Wayne,	Yes, rare,	Soft ground,	Only young plants.	
Wayne,	Have seen it very rarely,	Low grounds,		
Westmoreland,	West, very few,	Upland,		
Wyoming,	Quite rare,	Moist ground,	None.	
York,	It is, common,	It frequents meadows,		

Note—28 Mr. Rhoads states that in the collection of Acad. Nat. Science of Philadelphia, there are specimens of *S. aquaticus* from Philadelphia county, Ardmore, Montgomery county, Marple and Darby, Delaware county, and Morrisville, Bucks county, and specimens of *C. cristata* from two unknown Pennsylvania sources, and one from Wallingford, Delaware county, and that *S. aquaticus* is found by him in all parts of this State from the top of highest mountains to sea level, but is rare above 1,500 feet, at which elevation *C. cristata* seems to take its place.